

**STANDARDIZATION OF BROAD PARAMETERS
OF ROLLING STOCK
FOR METRO RAILWAYS IN INDIA**

APRIL 2017

I. Preface

This document lays down the broad mandatory parameters of rolling stock for metro rail systems in India. It will be applicable with immediate effect to all new metro systems in India which are being implemented with financial support from Government of India.

Existing metro rail systems, their extensions and projects in progress prior to the publication of these specifications are not bound by the requirements of these specifications as long as they are technically required to continue as per their existing specifications.

II. Specifications

A. Standards

1.0 Level of automation in train operations

- 1.1 The orders of Metro Rolling Stock (RS) shall be compliant to the requirements of Un-attended Train Operation (UTO), otherwise named as Grade of Automation, GoA4 level.
- 1.2 The other systems of signalling, telecommunication, PSD etc., which interface with the rolling stock shall be capable of GoA4 level of operation. The RS and other systems shall comply with the required UIC/EN/IEEE standards for UTO. However, the concerned Metro Railways may exercise their option to operate the trains in UTO mode in a phased manner.

2.0 Schedule of Dimensions

- 2.1 **(Type 1):** Medium Rail Metro with 16T axle load is normally adopted for passenger capacity up-to 45,000 PHPDT. The track curves of radius normally up-to 120 m is adopted in such Metros. The car body width of 2.9m is to be adopted as the standard dimension.
- 2.2 **(Type 2):** Heavy Rail Metro with 17T axle load is normally adopted for passenger capacity above 45,000 PHPDT. The curves of normally up-to 200 m is adopted in such Metros. The car body width of 3.2m is to be adopted as standard dimension.
- 2.3 Car length may be up-to a maximum of 23 meters.
- 2.4 Standard rail gauge of 1435 mm to be adopted.
- 2.5 Minimum clearance of any Rolling Stock equipment (Car body/bogie mounted equipment) from top of rail (ToR) should be 65 mm in static condition.
- 2.6 Schedule of Dimensions should specify the limitations of wheel flange, root and tread dimensions instead of wheel profile.

3.0 Emergency Evacuation System

- 3.1 Front evacuation for both 25 KV and third rail based metros,

3.2 Provision of Fire/ smoke detectors required in the saloon in case of front evacuation, as per EN45545.

4.0 Train performance parameters

4.1 Motorisation:

Minimum 67% motorisation for all categories of Metro Rolling Stock

4.2 Parameters:

Item	values
Minimum Design Average Acceleration rate for fully loaded (seating plus standees @ 8 passengers /sq.m) train on level tangent track shall be as under: 0 kmph to 40 kmph 0 to 60Kmph 0to 80Kmph	1.0 m/s ² 0.6 m/s ² . 0.3 m/s ²
Minimum Operational Average Acceleration rate for (seating plus standees @ 6 passengers/sq.m) loaded train on level tangent track shall be as under: 0 kmph to 35 kmph 0 to 60Kmph 0 to 80Kmph	1.20 m/s ² 0.65 m/s ² . 0.35 m/s ²
Service braking rate from 80 kmph to standstill for fully loaded (seating plus standees @ 8 passengers /sq.m) train on level tangent track	1.0 m/s ²
Service braking rate from 80 kmph to standstill for - (seating plus standees @ 6 passengers/sq.m) train on level tangent track	1.1 m/s ²
Emergencybraking rate from 80 kmph to 0 kmph for fully loaded train on level tangent track	1.3 m/s ²
Jerk rate (Maximum)	0.75 m/s ³

4.3 Maximum speed:

Max. Operating speed is standardised to be 80Kmph.

Max. design speed is standardised to be 90Kmph.

5.0 Energy Consumption:

5.1 The SEC at pantograph/current collector level under all-out running conditions should be less than:

5.1.1 50 kWh/1000 GTKM in the case of 25kV AC traction

5.1.2 60 kWh/1000 GTKM in the case of 750V DC traction

6.0 Train configuration

6.1 The train configuration will be of either 3-car, 6-car or 9-car formation only.

6.2 The Traction system shall be either 750 V DC third rail system or 25 kV AC OHE.

6.3 The Metros may opt for the optimum number of cars for the train formation (i.e. 3cars, 6 cars or 9 cars in line with the civil structure/platform capacity from the first stage itself) to avoid interface issues on account of conversion at later stages and cost escalation due to additional scope changes.

6.4 Signalling system shall be Communication Based Train Control (CBTC) with Auto reversal function at terminal stations.

7.0 Noise and Vibration level

7.1 Interior Noise Levels ($L_{PAeq20sec}$)

Location (Section)	Interior Noise Measurements in MaximumdBA		
	Stationary		Running (Elevated and At grade)
	Elevated	Under ground	75Kmph
All cars except in driving cab (Elevated and at grade)	68	75	75
Driving Cab (Elevated and at grade)	68	72	70

7.2 Exterior Noise Levels($L_{PAeq20sec}$)

Maximum Level of Exterior Noise in dBA @ 7.5 m from center of track on either sides	
Stationary	Running at 75Kmph
67	82

7.3 Standards ISO 3095 for external noise and ISO 3381 for internal noise should be followed.

7.4 Standard for vibration - ISO 2631– 1 1997, ISO 2631-4 2001 should be followed. All equipment, auxiliaries mounted at any position on the car shall have below mentioned criteria:

- A. 2.0 mm peak to peak vibration amplitude – frequency range from 1.4 Hz to 20 Hz
 - B. 0.8 mm per second peak vibration velocity – frequency range above 20Hz
- 7.5 Measurement method for noise should to be mentioned in the technical specification of the metros.
- 7.6 Door Operation Noise produced by simultaneous operation of all saloon doors on one side of the car shall not exceed 75dBA during the sliding operation and 78 dBA for the locking/unlocking, measured on the fast meter scale. This should be measured at all points in the car 300mm from the doors and 1000mm above the floor level
- 8.0 Coupling arrangement (Semi-automatic, Semi Permanent, etc.)**
- 8.1 The coupler between cars will be semi-permanent coupler with mechanical as well as pneumatic connection as part of the coupling.
 - 8.2 The coupler at the end of train (for coupling train to train) will be Semi-automatic coupler without electrical coupling.
 - 8.3 Maintenance / Depot facility should have full train length i.e. 3/6/9 car lifting facility with synchronized jacks.
- 9.0 Fire protection system in Metro Trains**
- 9.1 Two fire extinguishers per car in saloon area. One fire extinguisher per cab to be provided.
 - 9.2 All materials used for construction of metro car shall comply with International standards EN 45545 for fire & smoke.
 - 9.3 Fresh air intake to the saloon area of the car shall have smoke detection system to prevent entry of external smoke into the saloon area.
- 10.0 Warranty clauses and Maintenance**
- 10.1 Maintenance with involvement of suppliers is an option which may be exercised by the concerned Metro Railway, especially in case of small metro. Maintenance contract, if opted for, should be made a part of the base contract for a period of 5 to 7 years.
- 11.0 Service life and mid-life refurbishment**
- 11.1 The service life of the complete train is specified as 35 years.
 - 11.2 The mid-life refurbishment period shall be specified and obtained as part of the basic train data from the tenderers.
- 12.0 HVAC capacities**
- 12.1 The option is left to the concerned metros as the environment conditions varies and also fluctuates widely over various cities of India.

12.2 Coefficient of Performance should be at-least 2.5.

13.0 Collision standards

13.1 The compressive strength of the vehicle, energy absorption abilities and the anti-climbing features should be essentially made part of the technical specification for metro rolling stock.

13.2 In general, the parameters under EN 12663 and EN 15227 should to be followed.

14.0 Train accessibility standards

14.1 All the regulations as per “The persons with disabilities [equal opportunities, protection of rights and full participation] Act, 1995” shall be followed for the Rolling Stock construction and features.

**STANDARDIZATION OF BROAD PARAMETERS
OF SIGNALLING SYSTEMS FOR METRO
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MANDATORY GUIDELINES FOR STANDARDIZATION OF BROAD PARAMETERS AND INDIGENIZATION OF METRO RAILWAY SIGNALLING AND TRAIN CONTROL

1.0 Applicability

- 1.1 The intent of these guidelines is to facilitate and incentivise local sourcing and local manufacturing of signalling and train control solutions.
- 1.2 The requirements defined in this document are based on IEEE Std. 1474.1-2004¹. Wherever the requirements given in these guidelines exceed or limit the specifications given in IEEE 1474.1-2004¹, the requirements of these guidelines shall prevail.
- 1.3 These guidelines have been formulated in keeping with “General Guidelines for Signalling and Train Control Systems for Metro Railways”² approved by Railway Board, Ministry of Railways.
- 1.4 These guidelines shall be applicable to the full range of transit applications for rail based mass rapid transit system.
- 1.5 These guidelines shall be applicable to all metros with immediate effect from the date of publishing. Existing signalling and train control installations, their extensions and projects in progress prior to the publication of these specifications are not bound by the requirements of these guidelines.

2.0 System of Working

- 2.1 The Continuous Automatic Train Control system of working based on communication based train control system (CBTC) shall be adopted on the metro railway for movement of trains between stations. CBTC system shall be based on moving block. The choice of CBTC as a technology is based on the present techno-commercial evaluation and is subject to periodic review as decided by MoUD from time to time.
- 2.2 Depot area may be equipped with similar CBTC system or a suitable interlocking system as per requirement of the metro railway.
- 2.3 Wireless communication system shall be used for communication between the wayside and train borne CBTC system.
- 2.4 CBTC system shall be capable of providing bidirectional movement.

3.0 Grade of Automation / Modes of Operation

- 3.1 CBTC system shall be able to operate the train at different grades of automation viz.
 - (i) Unattended Train Operation (UTO)/GOA4
 - (ii) Driverless Train Operation (DTO)/GOA3
 - (iii) Automatic Train Operation (ATO)/GOA2
 - (iv) Semi Automatic Train Operation (STO)/GOA1

(v) Automatic Train Reversal Mode (ATR)

- 3.2 The grade of automation is specific to individual installations and based on traffic requirements, headways and availability of trained manpower. Therefore, the decision of grade of automation is left to the metro railway.
- 3.3 Higher level of automation shall necessitate provision of commensurating functions to ensure adequate level of safety and availability such as platform screen doors, automatic public announcements in the trains, train borne passenger surveillance from centralized location, remote rescue etc.
- 3.4 Centralized Operation Control Centre (OCC) shall be setup to monitor and control Signalling and Train Control system of a line including associated auxiliary systems. Backup Control Centre (BCC) shall also be setup for UTO/ DTO operation.
- 3.5 CBTC shall be designed to be upgradable to higher automation level, i.e. the hardware and software shall be of modular design so that additional functionality can be added later as and when required.

4.0 Degraded Modes of Operation

- 4.1 CBTC system shall support degraded modes of operation in the event of failure and shall continue to provide train protection with minimum reliance on adherence to operating procedures.
- 4.2 CBTC system shall support following degraded modes of train operation-
 - (i) For CBTC system failure affecting a particular train, Restricted Manual mode (RM/ROS) and Cut-out mode shall be provided.
 - (ii) For CBTC system failure affecting ATP working within a particular area of control, a fall back system shall be provided. This fallback system, as a minimum, shall consist of fixed colour light signals located such that safe route setting at points and crossing is assured.

5.0 Train Configuration

- 5.1 CBTC system shall support fixed length bidirectional 3 car / 6 car/ 9 car train configuration.
- 5.2 CBTC system shall support mixed operation of 3 car, 6 car and 9 car train configuration (as per requirement of the metro railway).
- 5.3 CBTC system shall be capable of supporting a mixed fleet of trains, where specific trains and/or classes of trains have different performance characteristics.

6.0 Train Operating Speed

- 6.1 CBTC system shall be capable of meeting the performance requirement of these specifications over full range of possible train operating speeds.
- 6.2 The UTO/DTO/ATO system shall interface with the rolling stock system and provide control for acceleration, deceleration and coasting of trains in such a

manner that it is possible to achieve specified schedule speed with minimum energy consumption.

7.0 Headway

- 7.1 The headway of the system shall be decided by the metro railway after taking in consideration additional factors outside the control of CBTC system viz. track alignment, gradients, civil speed limits, train acceleration and braking rates, station dwell times, terminal track configurations, driver reaction times etc.
- 7.2 Following should be optimised so as to obtain the stated headway of the metro railway: (a) maximum speed on the section and crossover (b) timers for release of sub routes within section/ siding / reversal platforms (c) length and release time of overlap (d) platform entry speed of trains etc .

8.0 Design Life

- 8.1 CBTC equipment shall have design life of 30 years.

9.0 Train Location Determination

- 9.1 Primary train location determination shall be done by CBTC, independent of track circuit/axle counter.
- 9.2 Secondary Train location determination for facilitation of fallback arrangement shall be done using track circuit/axle counter, as specified by the metro railway.

10.0 Implementation of Vital CBTC Functions

- 10.1 Vital functions of CBTC system that provide fail safe protection against collisions, excessive speed and other hazardous conditions shall be designed and implemented in accordance with fail-safe principles.

11.0 CBTC System Architecture

- 11.1 The architecture of CBTC system should be such that various sub-systems viz. Interlocking, ATP and ATS are physically and logically separate.
- 11.2 The architecture of ATS sub-system should be such that ATS core function and ATS non-core functions are physically and logically separable.

12.0 Train Wayside Communication (TWC)

- 12.1 CBTC train to wayside communication shall preferably use commercially off the shelf product (COTS) wireless communication equipment.
- 12.2 TWC interface shall be sufficient to support required ATP, ATO, DTO, UTO functions.
- 12.3 TWC shall provide continuous geographic coverage within CBTC territory and shall support train operations in tunnel, tubes and cuts, on elevated structures and at grade.

- 12.4 TWC shall support bidirectional data transfer and shall exhibit sufficiently low latency to support the defined performance requirements.
- 12.5 TWC shall include a protocol structure to support safe, timely and secure delivery of train control messages.

13.0 Power Supply

- 13.1 Uninterrupted Power Supply provision is a must for the Signalling system to have high availability.
- 13.2 The uninterrupted power supply system shall have sufficient backup time and built-in redundancies to ensure very high level of Availability and Reliability. Metro railway may specify the extent of redundancy required.

14.0 Platform Screen Doors

- 14.1 Platform screen doors, where provided, shall be interfaced with the CBTC system to ensure opening and closing of the Platform doors based upon train positioning/docking and commands from the signalling system.
- 14.2 The CBTC system shall be able to provide suitable inputs to the PSD system for the above functionality.

15.0 Indigenisation⁵

- 15.1 Metros shall try to procure maximum possible items from local sources. In this direction, following equipment shall be procured indigenously:
- a) Point machine for depot
 - b) UPS, Power Distribution Cubicle and associated system
 - c) Cables
 - d) LED based signals
 - e) Direct Line Projectors
 - f) Site accessories viz. computers, workstations and servers (recommended)³
 - g) Point machine for mainline(recommended)³
 - h) Track circuit/ Axle counter(recommended)³
 - i) Electronic interlocking (recommended)³
- 15.2 Metros shall try to develop maximum possible local competence so that knowhow and technical support is available locally within India as far as possible. The Signalling and Train control project implementation shall have Indian partner(s), who would take up following works:
- a) ATS non-core functions⁴ comprising of the following:
 - Interface for public announcements and passenger information system

- Provide interface with passenger surveillance systems (for DTO/UTO operation)
- Provide interface with the communication system for passengers and staff (for DTO/UTO operation)

Besides, metros may decide indigenization of following additional functions:

- Time table generation
 - Time distance graph
 - Fault reporting
 - Control traction power
 - Manage operational disturbances
 - Manage rolling stock and staff resources (crew management)
 - Support maintenance by interfacing with external maintenance management system
 - Supervise infrastructure external to CBTC system
- a) Preparation of signalling plan, control table, application drawings
 - b) Site installation, testing and commissioning
 - c) Safety assurance
 - d) Integration for the sub-system/ modules sourced from India
 - e) Life-time spares management
 - f) Data preparation of ATP, Interlocking and ATS (recommended)³
 - g) Extension, modification and re-signalling works in future as lead partner (recommended)³

15.3 Different metros shall try to synchronize their procurements to bundle volumes whereby (a) local companies are encouraged to set-up manufacturing facilities in India and (b) adequate volume of business is generated for the Indian partner for it to develop capability and competence.

Notes:

1. IEEE 1474.1 establishes a set of performance and functional requirements necessary for enhancing performance, availability, operations and train protection using a CBTC system. At present, it is the only available international standard defining the performance and functional requirements to be satisfied by CBTC system.
2. “General Guidelines for signalling and Train Control Systems for Metro Railways” submitted by RDSO brings out comprehensively generic and functional requirements, key performance parameters, maintenance and repair requirements and measures for indigenization/ local sourcing, tabular presentation for the systems and requirements regarding Signal and Telecommunication.
3. The intention of writing "Recommended" is to specify that individual metros are encouraged to take up this item under the head where it appears while recognizing at the same time the challenges involved in taking this step at this stage.
4. ATS non-core functions are those not directly interfacing with interlocking and ATP safety functions.
5. From the point of view of indigenization, Indian Railways have adopted "Policy for cross acceptance/ approval of Software Embedded Electronics Railway Signaling Systems and New/Imported Technology Products for Railway Signaling issued vide Railway Board letter no. 2012/Sig/SGF/7 dt 6.3.2014. This policy may be suitably made use of.